CLAIMS

What is claimed is:

1. A method for interchanging wavelengths in a multi-wavelength system having W wavelength channels, the method comprising the steps of:

selectively directing a pair of adjacent frequency channels corresponding to a respective pair of adjacent wavelength channels based upon a routing algorithm;

interchanging the frequencies of the selectively directed pair of adjacent frequency channels; and

selectively shifting the interchanged frequencies of the selectively directed pair of adjacent frequency channels based upon a binary representation of each interchanged frequency.

2. The method as defined in claim 1, wherein the step of selectively directing the pair of adjacent frequency channels comprises the step of:

selectively switching the pair of adjacent frequency channels to one of two output pairs.

3. The method as defined in claim 1, wherein the step of interchanging the frequencies of the selectively directed pair of adjacent frequency channels comprises the step of:

routing the selectively directed pair of adjacent frequency channels based upon a binary representation of the frequency of each of the selectively directed pair of adjacent frequency channels.

4. The method as defined in claim 3, wherein the step of interchanging the frequencies of the selectively directed pair of adjacent frequency channels further comprises the steps of:

shifting the frequency of a first of the selectively directed pair of adjacent frequency channels by an amount defined by $+\Delta f$; and

shifting the frequency of a second of the selectively directed pair of adjacent frequency channels by an amount defined by $-\Delta f$;

wherein Δf is the frequency spacing between the pair of adjacent frequency channels.

5. The method as defined in claim 1, wherein the step of selectively shifting the interchanged frequencies of the selectively directed pair of adjacent frequency channels comprises the step of:

routing the selectively directed pair of adjacent frequency channels based upon the binary representation of each interchanged frequency.

6. The method as defined in claim 5, wherein the step of selectively shifting the interchanged frequencies of the selectively directed pair of adjacent frequency channels further comprises the step of:

shifting the frequency of at least one of the selectively directed pair of adjacent frequency channels by an amount defined by $\pm(2^h-1)\Delta f$, wherein $h=0,\ldots,w-1$, $w=\log_2 W$, and Δf is the frequency spacing between the pair of adjacent frequency channels.

7. The method as defined in claim 5, wherein the step of selectively shifting the interchanged frequencies of the selectively directed pair of adjacent frequency channels further comprises the steps of:

shifting the frequency of at least one of the selectively directed pair of adjacent frequency channels by an amount defined by $-2^h\Delta f$;

increasing the shifted frequency of the at least one of the selectively directed pair of adjacent frequency channels; and

shifting the increased shifted frequency of the at least one of the selectively directed pair of adjacent frequency channels by an amount defined by $+\Delta f$;

wherein $h=0,\ldots,w-1$, $w=\log_2 W$, and Δf is the frequency spacing between the pair of adjacent frequency channels.

8. The method as defined in claim 5, wherein the step of selectively shifting the interchanged frequencies of the selectively directed pair of adjacent frequency channels further comprises the steps of:

shifting the frequency of at least one of the selectively directed pair of adjacent frequency channels by an amount defined by $-\Delta f$;

decreasing the shifted frequency of the at least one of the selectively directed pair of adjacent frequency channels; and

shifting the decreased shifted frequency of the at least one of the selectively directed pair of adjacent frequency channels by an amount defined by $+2^h\Delta f$;

wherein $h=0,\ldots,w-1$, $w=\log_2 W$, and Δf is the frequency spacing between the pair of adjacent frequency channels.

9. An apparatus for interchanging wavelengths in a multi-wavelength system having W wavelength channels, the apparatus comprising:

a switching element for selectively directing a pair of adjacent frequency channels corresponding to a respective pair of adjacent wavelength channels based upon a routing algorithm;

a state changer for interchanging the frequencies of the selectively directed pair of adjacent frequency channels; and

a connection module for selectively shifting the interchanged frequencies of the selectively directed pair of adjacent frequency channels based upon a binary representation of each interchanged frequency.

10. The apparatus as defined in claim 9, the switching element comprises:

a cross-connect for selectively switching the pair of adjacent frequency channels to one of two output pairs.

11. The apparatus as defined in claim 9, wherein the state changer comprises:

a router for routing the selectively directed pair of adjacent frequency channels based upon a binary representation of the frequency of each of the selectively directed pair of adjacent frequency channels.

12. The apparatus as defined in claim 11, wherein the state changer further comprises:

a first frequency shifter for shifting the frequency of a first of the selectively directed pair of adjacent frequency channels by an amount defined by $+\Delta f$; and

a second frequency shifter for shifting the frequency of a second of the selectively directed pair of adjacent frequency channels by an amount defined by $-\Delta f$;

wherein Δf is the frequency spacing between the pair of adjacent frequency channels.

13. The apparatus as defined in claim 9, wherein the connection module comprises:

a router for routing the selectively directed pair of adjacent frequency channels based upon the binary representation of each interchanged frequency.

14. The apparatus as defined in claim 13, wherein the connection module further comprises:

at least one frequency shifter for shifting the frequency of at least one of the selectively directed pair of adjacent frequency channels by an amount defined by $\pm(2^h-1)\Delta f$, wherein $h = 0,\ldots,w-1$, $w = \log_2 W$, and Δf is the frequency spacing between the pair of adjacent frequency channels.

15. The apparatus as defined in claim 13, wherein the connection module further comprises:

a first frequency shifter for shifting the frequency of at least one of the selectively directed pair of adjacent frequency channels by an amount defined by $-2^h\Delta f$;

an increasing up-converter for increasing the shifted frequency of the at least one of the selectively directed pair of adjacent frequency channels; and

a second frequency shifter for shifting the increased shifted frequency of the at least one of the selectively directed pair of adjacent frequency channels by an amount defined by $+\Delta f$;

wherein $h = 0,\ldots,w-1$, $w = \log_2 W$, and Δf is the frequency spacing between the pair of adjacent frequency channels.

16. The apparatus as defined in claim 13, wherein the connection module further comprises:

a first frequency shifter for shifting the frequency of at least one of the selectively directed pair of adjacent frequency channels by an amount defined by $-\Delta f$;

an increasing down-converter for decreasing the shifted frequency of the at least one of the selectively directed pair of adjacent frequency channels; and

a second frequency shifter for shifting the decreased shifted frequency of the at least one of the selectively directed pair of adjacent frequency channels by an amount defined by $+2^h\Delta f$;

wherein $h = 0,\ldots,w-1$, $w = \log_2 W$, and Δf is the frequency spacing between the pair of adjacent frequency channels.